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(54) SEMICONDUCTOR DEVICE AND MANUFACTURE OF THE SAME

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a semiconductor device of high reliability.

SOLUTION: An insulating film 2 is accumulated on a silicon substrate 1, and a resist 3 is patterned in a pattern inverted of a wiring pattern by lithographic technique. The insulating film 2 is etched by using a resist 3 as a mask and grooves 8 can be formed at the positions of the wiring pattern, and an aluminum-based or copper-based material polycrystalline metal film 4 is accumulated on the insulating film 2 in which grooves 8 are formed. One part of the metal film 4 is fused through laser irradiation or heater heating, and an aluminum system or copper system material monocrystal which is a seed crystal is brought into contact with the fused part, and after the laser or the heater is moved, the fused part is moved gradually so that the metal film 4 can be monocrystalized. The excess metallic film 4 is removed through by chemical- mechanical polishing, and a flat wiring layer is formed in the groove 8. Thus, wiring formation with electromigration resistance and stress migration resistance can be attained.

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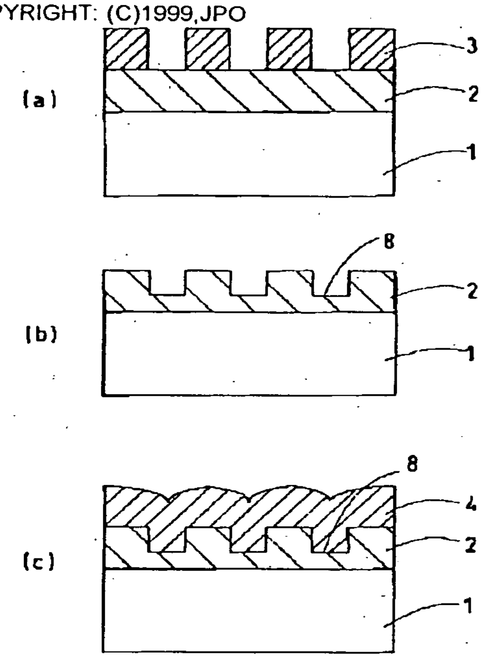

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the semiconductor device which has the high-reliability wiring excellent in electromigration-proof nature and stress migration-proof nature, and its manufacture method.
[0002]
[Description of the Prior Art] Wiring of the conventional semiconductor device was manufactured by the method as shown below. First, after forming elements, such as a transistor, on a semiconductor substrate, a layer insulation film is deposited and the contact hole for electrical installation is opened in a still more nearly required part. Subsequently, the metal membrane which deposits an aluminum system or copper system material, and is wiring is formed. And patterning of the photoresist is carried out to the shape of an above-mentioned metal membrane according to a photolithography process at a circuit pattern, the above-mentioned metal membrane is **********ed by using the above-mentioned photoresist as a mask at the last, and the wiring which consists of a polycrystal metal membrane is obtained by removing the above-mentioned photoresist further.
[0003]
[Problem(s) to be Solved by the Invention] On the other hand, detailed-ization of the wiring which connects between each element is also advanced with high integration of a semiconductor device, and detailed-izing. And the demand to properties, such as electromigration-proof nature and stress migration-proof nature, is becoming severe as detailed-ization progresses.
[0004] It generates, in order that the electron which flows wiring under current density with high electromigration may perform exchange of a metal ion and momentum and may push aside a metal ion to a positive side gradually. In the wiring which consists of a polycrystal metal membrane, movement of ion becomes uneven in the grain boundary, and the excess and deficiency of ion arise by the place. And in the portion for which ion was insufficient, a short circuit with the wiring which adjoins by growth of a hillock takes place in the portion from which the open circuit by growth of a void became superfluous.
[0005] Moreover, it is the phenomenon of a metal atom moving in order to ease the stress produced by the differential thermal expansion with the passivation film covered in order to protect the metal and it which constitute wiring with a stress migration, and a void arising as a result, and resulting in an open circuit. Although it was a problem important when electromigration-proof nature and stress migration-proof nature raise the reliability of a semiconductor device from the above thing, this problem was not solved in the above-mentioned conventional semiconductor device.
[0006] Therefore, the purpose of this invention is having been made in order to solve the above-mentioned trouble, and offering a reliable semiconductor device and its manufacture method.
[0007]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the semiconductor device of this invention according to claim 1 is characterized by forming the wiring on the layer insulation film deposited on the semiconductor substrate with the single crystal of the wiring material by which crystal orientation was controlled. Thus, since wiring is formed with the single crystal of the wiring material by which crystal orientation was controlled, the wiring formation

which has the electromigration-proof nature which was excellent compared with the conventional polycrystal wiring, and stress migration-proof nature is attained.
[0008] In a claim 1, the wiring material of a semiconductor device according to claim 2 is an aluminum system or copper system material. Thus, since this was single-crystal-ized by making a wiring material into an aluminum system or copper system material, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional aluminum system or polycrystal wiring of copper system material, and stress migration-proof nature is attained.

[0009] In a claim 1, wiring consists of a single crystal of aluminum system material, and a semiconductor device according to claim 3 has the perpendicular shaft (111) of the crystal to a semiconductor substrate front face. In the wiring which consists of the polycrystal of aluminum system material, electromigration-proof nature improves, so that the plane orientation (111) nature of aluminum is high. Therefore, wiring consists of a single crystal of aluminum system material, and electromigration-proof nature and stress migration-proof nature improve [in / this perpendicular equipment / in the shaft (111) of the crystal] further to a semiconductor substrate front face.
[0010] In a claim 1, wiring consists of a single crystal of copper system material, and a semiconductor device according to claim 4 has the perpendicular shaft (111) of the crystal to a semiconductor substrate front face. Also in the wiring which consists of the polycrystal of copper system material, electromigration-proof nature improves, so that copper plane orientation (111) nature is high. Therefore, wiring consists of a single crystal of copper system material, and electromigration-proof nature and stress migration-proof nature improve [in / this perpendicular equipment / in the shaft (111) of the crystal] further to a semiconductor substrate front face.
[0011] The process at which the manufacture method of a semiconductor device according to claim 5 deposits an insulator layer on a semiconductor substrate, The process which carries out patterning of the resist to a circuit pattern with lithography technology at the pattern of reversal, The process which **********s the aforementioned insulator layer by using the aforementioned resist as a mask, and forms a slot in the position of a circuit pattern, The process which deposits the polycrystal film of a wiring material on the insulator layer in which the aforementioned slot was formed, After contacting the single crystal of the wiring material which fuses a part of aforementioned metal membrane, and serves as seed crystal to a fusion zone, the process which single-crystal-izes the aforementioned metal membrane, and the process which removes the single-crystal-ized excessive portion of a metal membrane, and forms a flat wiring layer in aforementioned Mizouchi are included by moving a fusion zone gradually.
[0012] Thus, since melting recrystallization is carried out and the polycrystal metal membrane which should serve as wiring deposited on the substrate by carrying out melting of a part of metal membrane, attaching the seed crystal which consists of a single crystal which has the same composition as a metal membrane into the fused portion, and moving a fusion zone gradually is single-crystal-ized, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional polycrystal wiring, and stress migration-proof nature becomes possible. Moreover, since the crystal orientation of the single crystal obtained is dependent on the crystal orientation of seed crystal, in case seed crystal is attached to a fusion zone, the single crystal metal membrane which has desired crystal orientation can be obtained by controlling crystal orientation.
[0013] In a claim 5, the wiring material of the manufacture method of a semiconductor device according to claim 6 is an aluminum system or copper system material. Thus, since this is single-crystal-ized by making a wiring material into an aluminum system or copper system material, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional aluminum system or polycrystal wiring of copper system material, and stress migration-proof nature is attained.
[0014] In a claim 5, the manufacture method of a semiconductor device according to claim 7 fuses a part of metal membrane by laser radiation or heater heating, moves laser or a heater, and moves a fusion zone. Thus, a part of metal membrane can be fused by laser radiation or heater heating, and the whole metal membrane can be single-crystal-ized by moving laser or a heater and moving a fusion zone.

[0015] The manufacture method of a semiconductor device according to claim 8 removes the single-crystal-ized excessive portion of a metal membrane by chemical machinery polish (CMP) in a claim 5. Thus, a flat wiring layer can be formed in Mizouchi by removing the single-crystal-ized excessive portion of a metal membrane by chemical machinery polish.

[0016]

[Embodiments of the Invention] The gestalt of implementation of this invention is explained based on drawing 1 - drawing 3 . The process cross section in which drawing 1 shows the cross section of the semiconductor device of the gestalt of implementation of this invention, and drawing 2 shows the manufacture method of the semiconductor device of the gestalt implementation this invention, and drawing 3 are the conceptual diagrams showing the process which fuses a metal membrane in the manufacture method of the semiconductor device of the gestalt implementation this invention. In drawing 1 , 1 is a silicon substrate and elements, such as a transistor, are formed. 2 is the layer insulation film deposited on it. A slot 8 is formed in the upper surface of the layer insulation film 2, and wiring 5 is embedded in this slot 8. Wiring 5 is formed with the single crystal of the wiring material by which crystal orientation was controlled, for example, an aluminum system, and copper system material. Moreover, the shaft (111) of the crystal is perpendicular to the front face (100) (field) of a silicon substrate 1.

[0017] Next, the manufacture method of the semiconductor device constituted as mentioned above is explained. As first shown in drawing 2 (a), after forming elements, such as a transistor, on a silicon substrate 1, the layer insulation film 2 is deposited. Next, patterning of the photoresist 3 is carried out to a circuit pattern according to a photolithography process at the pattern of reversal. The polycrystal metal membrane 4 which is wiring after forming the slot 8 of a circuit pattern as **********s and shows the layer insulation film 2 to drawing 2 (b) is deposited by using this photoresist as a mask.

[0018] Next, as shown in drawing 3 , melting is carried out by irradiating a part of polycrystal metal membrane 4 by laser 7. After making the crystal orientation of a request of the single crystal of the aluminum system or copper system material which becomes the fused portion with seed crystal 6 control and contact, the whole is single-crystal-ized by moving laser 7 in the direction of an arrow gradually. Thus, the single crystal wiring 5 which has the crystal orientation controlled by removing portions other than wiring by chemical machinery polish (CMP) etc. among the obtained single crystal metal membranes is obtained.

[0019] According to the gestalt of this operation, melting of a part of metal membrane 4 is carried out by laser 7 irradiation as mentioned above. By attaching the seed crystal 6 which becomes the fused portion from the single crystal which has the same composition as a metal membrane 4, moving laser 7, and moving a fusion zone gradually Since melting recrystallization is carried out and the polycrystal metal membrane 4 which should serve as the wiring 5 deposited on the substrate 1 is single-crystal-ized, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional polycrystal wiring, and stress migration-proof nature is attained. Moreover, since the crystal orientation of the single crystal obtained is dependent on the crystal orientation of seed crystal 6, in case seed crystal 6 is attached to a fusion zone, the single crystal metal membrane which has desired crystal orientation can be obtained by controlling crystal orientation.

[0020] Moreover, in the wiring which consists of the polycrystal of an aluminum system or copper system material, electromigration-proof nature improves, so that the plane orientation (111) nature of aluminum or copper is high. Therefore, in this equipment with which wiring consists of a single crystal of an aluminum system or copper system material, and the shaft (111) of the crystal is perpendicular to the front face (100) (field) of a silicon substrate 1, electromigration-proof nature and stress migration-proof nature improve further.

[0021] In addition, you may fuse a metal membrane by the means of heater heating or others instead of laser radiation.

[0022]

[Effect of the Invention] Since wiring is formed with the single crystal of the wiring material by which crystal orientation was controlled according to the semiconductor device of this invention according to claim 1, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional polycrystal wiring, and stress migration-proof nature is

attained:
[0023] In a claim 2, since this was single-crystal-ized by making a wiring material into an aluminum system or copper system material, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional aluminum system or polycrystal wiring of copper system material, and stress migration-proof nature is attained. In a claim 3, in the wiring which consists of the polycrystal of aluminum system material, electromigration-proof nature improves, so that the plane orientation (111) nature of aluminum is high. Therefore, wiring consists of a single crystal of aluminum system material, and electromigration-proof nature and stress migration-proof nature improve [in / this perpendicular equipment / in the shaft (111) of the crystal] further to a semiconductor substrate front face.
[0024] In a claim 4, also in the wiring which consists of the polycrystal of copper system material, electromigration-proof nature improves, so that copper plane orientation (111) nature is high. Therefore, wiring consists of a single crystal of copper system material, and electromigration-proof nature and stress migration-proof nature improve [in / this perpendicular equipment / in the shaft (111) of the crystal] further to a semiconductor substrate front face.
[0025] By according to the manufacture method of the semiconductor device this invention according to claim 5, carrying out melting of a part of metal membrane, attaching the seed crystal which consists of a single crystal which has the same composition as a metal membrane into the fused portion, and moving a fusion zone gradually Since melting recrystallization is carried out and the polycrystal metal membrane which should serve as wiring deposited on the substrate is single-crystal-ized, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional polycrystal wiring, and stress migration-proof nature is attained. Moreover, since the crystal orientation of the single crystal obtained is dependent on the crystal orientation of seed crystal, in case seed crystal is attached to a fusion zone, the single crystal metal membrane which has desired crystal orientation can be obtained by controlling crystal orientation.
[0026] In a claim 6, since this is single-crystal-ized by making a wiring material into an aluminum system or copper system material, the wiring formation which has the electromigration-proof nature which was excellent compared with the conventional aluminum system or polycrystal wiring of copper system material, and stress migration-proof nature is attained. In a claim 7, a part of metal membrane can be fused by laser radiation or heater heating, and the whole metal membrane can be single-crystal-ized by moving laser or a heater and moving a fusion zone.
[0027] In a claim 8, a flat wiring layer can be formed in Mizouchi by removing the single-crystal-ized excessive portion of a metal membrane by chemical machinery polish.

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CLAIMS

[Claim(s)]
[Claim 1] The semiconductor device characterized by forming the wiring on the layer insulation film deposited on the semiconductor substrate with the single crystal of the wiring material by which crystal orientation was controlled.
[Claim 2] The semiconductor device according to claim 1 whose wiring material is an aluminum system or copper system material.
[Claim 3] Wiring consists of a single crystal of aluminum system material, and the shaft (111) of the crystal is a perpendicular semiconductor device according to claim 1 to a semiconductor substrate front face.
[Claim 4] Wiring consists of a single crystal of copper system material, and the shaft (111) of the crystal is a perpendicular semiconductor device according to claim 1 to a semiconductor substrate front face.
[Claim 5] The manufacture method of a semiconductor device characterized by providing the following. The process which deposits an insulator layer on a semiconductor substrate. The process which carries out patterning of the resist to a circuit pattern with lithography technology at the pattern of reversal. The process which **********s the aforementioned insulator layer by using the aforementioned resist as a mask, and forms a slot in the position of a circuit pattern. The process which single-crystal-izes the aforementioned metal membrane by moving a fusion zone gradually after contacting the single crystal of the process which deposits the polycrystal film of a wiring material on the insulator layer in which the aforementioned slot was formed, and the wiring material which fuses a part of aforementioned metal membrane, and serves as seed crystal to a fusion zone, and the process which removes the excessive portion of the single-crystal-ized metal membrane, and forms a flat wiring layer in aforementioned Mizouchi.
[Claim 6] The manufacture method of a semiconductor device according to claim 5 that a wiring material is an aluminum system or copper system material.
[Claim 7] The manufacture method of the semiconductor device according to claim 5 to which a part of metal membrane is fused by laser radiation or heater heating, laser or a heater is moved, and a fusion zone is moved.
[Claim 8] The manufacture method of a semiconductor device according to claim 5 that chemical machinery polish (CMP) removes the single-crystal-ized excessive portion of a metal membrane.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross section of the semiconductor device of the gestalt of implementation of this invention.
[Drawing 2] It is the process cross section of the manufacture method of the semiconductor device of the gestalt of implementation of this invention.
[Drawing 3] It is the conceptual diagram showing the process which fuses a metal membrane in the manufacture method of the semiconductor device of the gestalt implementation this invention.
[Description of Notations]
1 Silicon Substrate (Semiconductor Substrate)
2 Layer Insulation Film
3 Photoresist
4 Polycrystal Metal Membrane
5 Wiring
6 Seed Crystal
7 Laser

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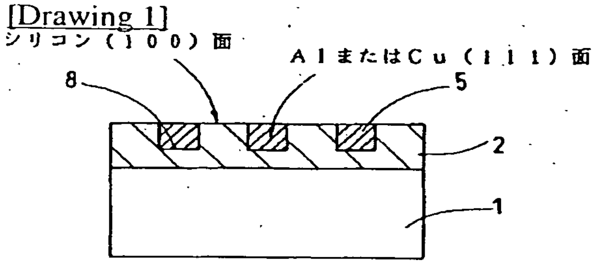
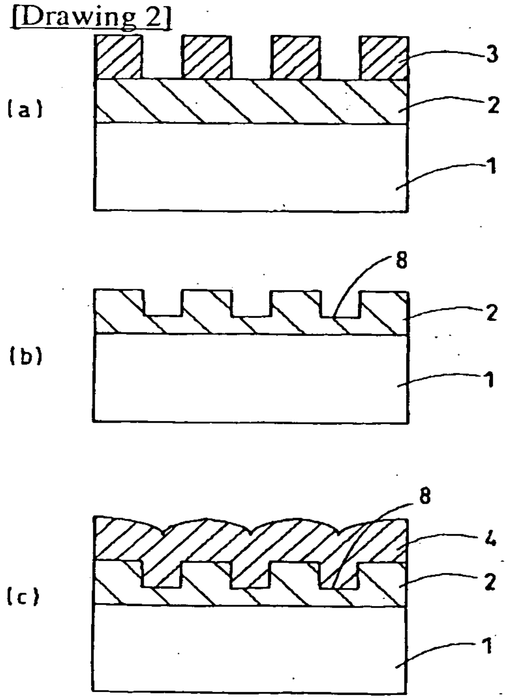
DRAWINGS

[Drawing 1]



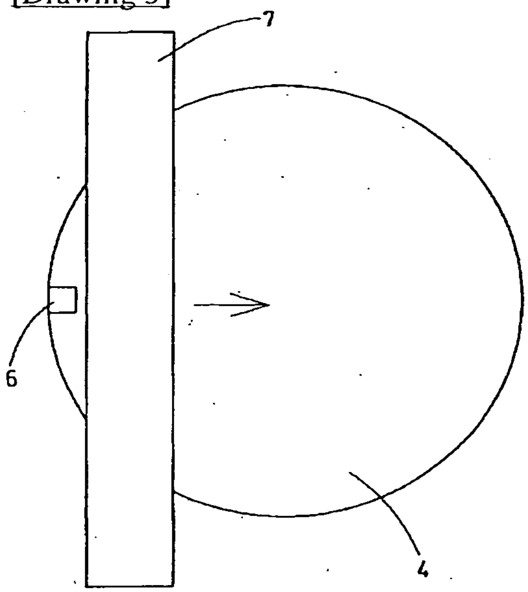
1 …シリコン基板
2 …層間絶縁膜
5 …配線

[Drawing 2]



3 …フォトレジスト
4 …多結晶金属膜

[Drawing 3]



6 …種結晶
7 …レーザ

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